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## Height fluctuations of granular river beds modeled as a stochastic process

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### ABSTRACT

The shaping of river beds by flowing water is an important problem in geophysics. Often, the process is studied by tracing the trajectories of some labeled sediments particles. This type of sediment tracer studies of bed load transport and geomorphic evolution are growing in popularity but lack sufficient physical basis for tracer interpretation. Bed load tracers spend most time trapped in the riverbed, indicating the importance of these sediment “waiting times” for tracer dynamics. Here, we propose the first process-based model to predict the waiting time distribution. Our model, based on the well-studied “Ornstein–Uhlenbeck” process, treats bed elevation as a random walk with mean-reverting tendency related to the maximal range of bed elevation fluctuations. Idealized flume experiments tracking bidisperse spherical beads propelled by steady water flow support our model and reveal the direct relationship between waiting times and bed evolution. Asymptotic power law scaling of observed and modeled waiting time distributions agree with experimental and field observations of natural bed load tracers, suggesting broad applicability of our model to fluctuating sedimentary surfaces and disordered transport systems experiencing tracer burial and excavation.